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Recent advances in processing of ground-based remote sensing observations and their application for NWP model evaluation.

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Results from several recent field campaigns will be discussed in which novel techniques for the processing of ground-based remote sensors have been developed, providing new opportunities for understanding atmospheric processes and for evaluating numerical weather prediction models. All three campaigns were jointly funded by the U.S. Department of Energy and NOAA. The XPIA (eXperimental Planetary boundary layer Instrumentation Assessment) campaign took place at the NOAA Boulder Atmospheric Observatory (BAO) in the spring of 2015. Instrumentation included five scanning Doppler lidars with variable scanning strategies; five additional vertical profiling lidars operated continuously while a sixth scanning lidar was run primarily in a vertical profiling mode. Additional instrumentation included two mobile scanning Ka-band radars, two wind profiling radars, two profiling microwave radiometers, and a radiosonde system, in addition to six levels of sonic anemometers on the BAO tower. The scanning lidars were used to create virtual towers, as well as horizontal wind fields using multiple configurations of lidar systems, including single scanning radar 3D wind retrievals using a Bayesian retrieval algorithm. Vertical profiles of turbulence dissipation rate were derived from radar wind profiler spectral widths using radar signal processing methods optimized for this parameter, and compared to dissipation rates provided by the sonic anemometers on the tower.

The POWER (Positioning of Offshore Wind Energy Resources) project made use of observations collected in 2004 for an air quality study in the Gulf of Maine off the northeastern U.S. seaboard, repurposed for evaluating boundary layer winds for wind energy applications. Instrumentation included a network of 11 inland wind profiling radars, and a scanning lidar and wind profiling radar on the R. V. Ron Brown which cruised through the Gulf of Maine. The impact of assimilation of the inland observations on wind forecasts offshore was assessed using the lidar and radar wind profiler on the R.V. Ron Brown.

WFIP2 (The second Wind Forecast Improvement Project) occurred in 2015-2017 in the Columbia River Gorge region of Oregon and Washington states in the Pacific Northwest region of the U. S. As part of WFIP2 a large suite of in-situ and remote sensing instrumentation has been deployed, including a network of three 449 MHz radar wind profilers with RASS, eight 915 MHz RWP's with RASS, 18 sodars, 4 profiling microwave radiometers, 5 scanning lidars, and 5 profiling lidars. Key NWP forecast models utilized for WFIP2 are the 13 km resolution Rapid Refresh (RAP), 3km High Resolution Rapid Refresh (HRRR), 0.75km HRRR-Nest, and the 12 km North American Mesoscale (NAM) forecast system. New methods of ground-based remote sensing, including those developed for XPIA, were applied to the WFIP2 observations, and were used to evaluate and improve the NWP forecast model parameterization schemes. Results from those evaluations that will be discussed include seasonal variations of model forecast errors of wind speed, direction, temperature and humidity profiles and boundary layer depths; meteorological phenomena producing large forecast errors; and the relative skill of the various NWP forecasting systems.